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Report of the PSARC Invertebrate Subcommittee Meeting, November 30 – December 2, 1999

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SUMMARY

The PSARC Invertebrate Subcommittee met 30 November to 2 December, 1999 at the Coast Bastion Hotel in Nanaimo, B.C. The Subcommittee reviewed seven Working Papers, one Fishery Update, and five Stock Status Reports.

Working Paper I99-17: Review of the Area 7 Manila Clam Fishery

This paper was the first analysis of the Area 7 (central B.C. coast) Manila clam fishery, which began in winter 1992/93. Average annual landings have been about 65% of the initial arbitrary Total Allowable Catch (TAC); sub-areas with consistent landings were identified. The Subcommittee recommended establishing a target reference point based on the average annual catch, and reducing the TAC to this reference point. The Subcommittee agreed with the recommendations from the paper regarding establishing index survey beaches and closer monitoring of catch and effort.

Working Paper I99-18: Framework for goose barnacle (*Pollicipes polymerus* Sowerby, 1833) fishery in waters off the West Coast of Canada

As a result of the Phase 0 literature review of the biology and fishery for gooseneck barnacles, the Resource Management Executive Committee (RMEC) closed this fishery in B.C. in May 1999. RMEC indicated that re-opening of the gooseneck barnacle fishery would depend on the results of an ecological assessment and meeting the Regional criteria for a new and developing fishery. This paper develops a Phase 1 approach that allows for the fishery to proceed cautiously in a manner which collects key information for assessment and management.

The Subcommittee supported recommendations in the paper dealing with the development of surveys, index sites, rotational harvests, and improved harvesting techniques. The Subcommittee recommended the top three research priorities should be to identify broad-scale distributions, to establish index study sites, and to obtain estimates of the proportion of the stock available to harvest. The Subcommittee also recommended establishing a working group of DFO staff and stakeholders to examine and implement these recommendations by May 2000.

Working Paper I99-19: *Pandalus hypsinotus*, Humpback shrimp: A review of the biology and a recommended assessment framework for a directed fishery

This paper developed an assessment and management framework for a directed fishery for *Pandalus hypsinotus* (humpback shrimp) in B.C. The paper concluded

that there is potential for targeted humpback shrimp fisheries in B.C., and suggested a precautionary framework within which to proceed. The Subcommittee recommended identifying the areas of interest for a *P. hypsinotus* fishery, and recommended that discussions occur with fisheries managers as to management options, appropriate biological reference points, and their data requirements.

Working Paper I99-20: A progress report on the controls of the growth and recruitment overfishing in the shrimp trap fishery in British Columbia

This paper was an update and analysis of data collected on spot prawn in B.C., with a particular focus on Howe Sound during the dioxin contaminant closure that started in 1988. The Subcommittee recommended that further work should be done to compare prawn population characteristics and dynamics between the closed and open parts of Howe Sound, and that further fishery-independent data series for prawns should be developed in other areas of the B.C. coast.

Working Paper I99-21: Assessment tools for data-limited fisheries

This paper presented a literature review and summary of biological reference points in fisheries. It was a timely introduction towards developing such reference points in Pacific Region's invertebrate assessments. The Subcommittee endorsed the recommendations to identify such formal reference points in assessments, and to establish pre-agreed actions should the limit reference points be approached.

Working Paper I99-22: Distribution, abundance, biology and fisheries potential of the exotic varnish clam (*Nuttallia obscurata*) in British Columbia

This paper provided a Phase 0 review of literature and data on the recent establishment of varnish clams in B.C. It suggested that varnish clams have potential as commercial and recreational resources, and should be managed accordingly. The Subcommittee endorsed the paper's recommendations regarding considering varnish clams as a fishing opportunity and incorporating varnish clams into the existing clam licence, rather than as a separate fishery. The Subcommittee also recognised the potential for impacts of a varnish clam fishery on Manila clams. The Subcommittee recommended work to develop reference points for varnish clams and to consider ecological interactions with other clam species.

Working Paper I99-23: Quota options for the red sea urchin fishery in B.C. for fishing season 2000/01

This paper presented quota options for the red sea urchin fishery in B.C. for 2000/01. It also presented a number of scenarios for changes to the size limits

(both minimum and maximum) of animals fished and presented quota options for each of these size limit scenarios.

The Subcommittee was concerned that analyses of data are not up-to-date, in particular with key measurements such as fishing bed areas which uses data only to 1996. Uncertainties in the analysis, for example relating to extrapolating information to unsurveyed areas, also need to be expressed more clearly. The Subcommittee was also concerned about the method used to survey and then to calculate urchin biomass in each sub-area, although it recognised the present method was conservative. The Subcommittee noted that the choice of alternative size limits is a fisheries management decision, and that the paper provided a guide to the implications of the different size limit scenarios for red urchin stocks.

Fishery Updates

Fisheries Management staff, in consultation with Conservation and Protection and Stock Assessment Divisions, prepare fishery updates. The updates provide summaries of commercial fishery performance, including significant management, enforcement, and stock assessment activities on an annual basis. The updates provide the opportunity to identify high priority issues that affect assessments and conservation concerns. The fishery update for red sea urchins was presented at this meeting.

Emerging Issues

Four emerging issues were identified by the Subcommittee during its deliberations:

1. *Sea otters and invertebrate species interactions.* Sea otters have successfully recolonised many areas of the B.C. coast, and their populations (and distributions) appear to be expanding. The Subcommittee recommended assessment of sea otter distributions, population growth rates, and their potential impacts to invertebrate populations, and presentation of results to the PSARC Invertebrate Subcommittee. The Subcommittee also recognised, however, that resources and expertise for such assessments are not presently available within DFO.
2. *Collection of abalone for aquaculture//enhancement.* A discussion paper was tabled outlining the rationale and protocol for the removal (and return) of allowable numbers of northern abalone, *Haliotis kamtschatkana*, from areas of B.C. for use as broodstock in aquaculture and enhancement. No specific recommendations were made. However, the Subcommittee wished to draw the attention of RMEC to this issue, and to the need for clearly defined objectives for the abalone aquaculture/enhancement program so that appropriate scientific methods can be applied.
3. *Application of selective fisheries guidelines to allocation issues.* There is general uncertainty over how to apply the developing DFO selective fisheries guidelines to invertebrate fisheries. The Subcommittee recommended

involving DFO selective fishing staff, and the PSARC Habitat Subcommittee when appropriate, during the evaluation of new and developing fisheries and to provide assistance with the application of the selective fishing policy to invertebrates.

4. *Lack of information (and controls) on non-commercial fisheries for invertebrates.* Removals by many non-commercial fisheries for invertebrates are poorly or un-documented. Recreational fisheries in particular are basically unlimited entry fisheries with no reporting requirements. The Subcommittee recommended that a system be developed to track and report invertebrate removals in particular from recreational fishing, but should also begin to include native food, social, and ceremonial use. This should focus on species and locations of concern as identified by Operations Branch.

INTRODUCTION

The PSARC Invertebrate Subcommittee met at the Coast Bastion Hotel, Nanaimo, B.C., from 30 November to 2 December, 1999 (there was no need to meet on 3 December as originally scheduled). The Subcommittee chair opened the meeting by welcoming the participants. He provided introductory remarks on the roles and responsibilities of the Subcommittee, and the roles and responsibilities of external participants and observers. The Subcommittee accepted the agenda (Appendix 1). During its proceedings, the Subcommittee reviewed seven working papers (Appendix 2), one fishery update, and five stock status reports. This Advisory Document provides the record of the Subcommittee's deliberations and recommendations.

A number of external participants and observers attended the meeting. All participants at the meeting and the days they attended are presented in Appendix 3.

EMERGING ISSUES

Four issues emerged from the meeting for special consideration:

Sea otters and invertebrate species interactions
Issue: Sea otters have successfully recolonised many areas of the B.C. coast, and their populations (and distributions) appear to be expanding.
Discussion: Sea otters are heavy predators on several commercially-important invertebrate species, including abalone, sea urchins, and crabs. Such increasing predation pressure on these species means that natural mortality (M) is increasing. In a sense, there is another user of the resource, which needs to be taken into account in the invertebrate assessments. It also suggests adopting a broader ecosystem approach to evaluate system interactions. Information is needed on what areas are now, and are likely to be in the near future, impacted by sea otters. How quickly are sea otter populations growing? What is their

predation rate and potential impacts to invertebrate species in these areas?
Recommendations: The Subcommittee recommended assessment of these issues and presentation of results to the PSARC Invertebrate Subcommittee; however, the Subcommittee also recognised that resources and expertise for such an assessment are not presently available within DFO.

Collection of abalone for aquaculture/enhancement
Issue: A discussion paper was tabled by A. Campbell, B. Lucas, and D. Brouwer outlining the rationale and protocol for the removal (and return) of allowable numbers of northern abalone, *Haliotis kamtschatkana*, from areas of B.C. for use as broodstock in aquaculture and enhancement.
Discussion: The discussion paper was prepared in response to requests on how to collect abalone for broodstock in developing aquaculture activities as part of the abalone rebuilding strategy. The Subcommittee agreed that the discussion paper had insufficient information or time for formal review, a need for more detail in some sections, and the need for approval of the collection methodology, and that it should be presented as an Emerging Issue. In particular, there is a need to clearly define the objective of the aquaculture program. For example, is it to restock a particular area (and therefore the brood stock should come from that area), or is it to provide stock for coastwide outplanting (in which case the broodstock could come from a single abundant area). The Subcommittee discussed the process for collecting abalone, as presented in the paper. There was some concern for the accuracy of assessments prior to collection, considering the cryptic nature of the animal. Suggestions were made to: consider a larger size of animal, in order that fewer be collected; and consider conducting all collections from a single site known for its reasonably large population, rather than risking already depleted areas elsewhere on the coast. The Subcommittee noted that genetic research is ongoing and will have implications for the enforcement of the harvest ban on abalone – it is essential that this work not be jeopardised by the dispersal of juvenile abalone produced from only one location on the coast. The Subcommittee recognised the importance of agreement with this project by coastal communities and First Nations.

Application of selective fisheries guidelines to allocation issues
Issue: There is general uncertainty over how to apply the developing DFO selective fisheries guidelines to invertebrate fisheries.
Discussion: The specific context under which this was raised is the interaction between mobile (trawl) and fixed (trap) gears for the shrimp fishery, and discussion on developing a directed fishery for humpback shrimp. Trawl catches are generally more diverse than trap catches, and the survival of animals returned to the sea after capture by trawls is unknown. It was suggested that DFO selective fishing staff should be consulted or involved in the evaluation of management options for species (and gears) proposed for new fisheries (e.g. Phase 0). Concerns were also expressed on recognising and comparing the relative habitat disruptions of different gear types. This should include

involvement of the PSARC Habitat Subcommittee. It was recognised by the Subcommittee that application of DFO's selective fishing policy is an Operations responsibility, but that evaluation of relative impacts is a PSARC responsibility.
Recommendation: The Subcommittee recommended involvement of DFO selective fishing staff in evaluating new and developing fisheries, and to provide assistance with the application of the selective fishing policy to invertebrates.

Lack of information (and controls) on non-commercial fisheries for invertebrates
Issue: Removals by many non-commercial fisheries for invertebrates are poorly or un-documented, although they may be extensive for some species in some areas. These non-commercial fisheries include recreational, and native food, social, and ceremonial use. Recreational fisheries in particular are basically unlimited entry fisheries with no reporting requirements.
Discussion: With many commercial fisheries for invertebrates being reduced or at least coming under closer monitoring, the Subcommittee recognised that removals of animals by recreational fishing in particular for some species in some areas (e.g. prawns; crabs – especially in the Greater Vancouver region) are unknown. Poaching may also be a significant problem. Recreational and native food, social, ceremonial removals need to be reported so that assessments can include total removals when evaluating stock status.
Recommendations: The Subcommittee recommended that a system be developed to track and report invertebrate removals in particular from recreational fishing, but should also begin to include native food, social, and ceremonial use. This should initially focus on species and locations of concern – such species and locations will need to be identified by Operations Branch.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

I99-17: Review of the Area 7 Manila Clam Fishery

G. Gillespie, T. Norgard and F. Scurrah
Accepted subject to revisions

Summary

The Area 7 clam fishery commenced in the winter of 1992/93. The fishery was managed under a total allowable catch of 113.6 t for each of Manila, littleneck and butter clams. There was one insignificant landing of littlenecks, and no butter landings. Manila landings peaked at 114.1 t in 1994/95, and averaged 73.5 t per season through 1998/99. This report reviews the development of the fishery, collects and interprets survey activities by the Heiltsuk Fisheries Program and Fisheries and Oceans Canada, characterises stock status, assesses the effect of the fishery on stock status, and provides recommendations for continuation of a sustainable Manila clam fishery in the area.

A relatively small number of subareas have sufficiently regular recruitment to

support a sustainable fishery. Most other subareas showed patterns of initial depletion of accumulated stocks, with limited recovery. Seven subareas were unfished or had extremely limited landings, although they had been open for several years.

The paper recommends a reduction in the total allowable catch to a level below average annual production, continuation of the assessment program, development of harvest log cards to obtain catch and effort information, and in-season monitoring of the fishery.

Reviewers' Comments

Reviewer #1

Reviewer 1 felt this paper provides an excellent summary of the history of the fishery, and noted the analyses are prioritised, and the paper provides a good basis on which to guide the future of the fishery. The objectives of the working paper are clearly stated. In addition, the authors give a review of Manila clam biology, the history of the Area 7 fishery, and the management framework historically used for the pilot fishery. The reviewer felt the assessment section gives a clear summary of the fishing and survey effort over the 7 seasons of the pilot fishery.

The reviewer felt the authors have done an excellent job of presenting what is likely the most accurate summary of the fishery possible. The data are presented in an orderly and consistent manner that is easy to follow and interpret. The authors have done an excellent job of pulling together the relevant information from different sources and using this information in the subsequent analysis. This reviewer felt the recommendations are extremely clear, appropriate, and relatively painless to implement, while bringing this fishery into an active management regime.

As an addition to Recommendation # 4 (regarding monitoring CPUE by subarea), many fishers are reporting landing by beach, as several beaches are harvested within a particular subarea, and this reviewer noted that perhaps CPUE monitoring could be expanded to a beach basis. While a statement was made that catch and effort reporting suffered due to a lack of continuity in staff and methods, there was no further discussion on the level of confidence in both survey and commercial harvest data. The reviewer noted there was also no discussion on the level of food harvest of manila clams, misreporting the commercial harvest or speculation on the impact of any illegal harvest. Since data are not available to quantify these concerns, it likely does not warrant further discussion.

Reviewer #2:

The reviewer commended the authors on the amount of work they have done to pull together this information, and the reviewer is pleased to see that detailed data are being recorded from the beginning of the fishery. A paper is being prepared summarising information on Manila clam distribution and populations over the past 15 years, and some of the data presented in this working paper will be incorporated in that paper. The reviewer has no major criticisms of this paper. The reviewer had some comments as to when Manila clams were first found in B.C., the introduction of Manilas to the North Coast, and the existence of subtidal populations. The unusual conditions that are conducive to Manila clam recruitment should be mentioned and that a return to the normal oceanographic regime may lead to recruitment failures in Manila clams in this Area. The reviewer is not aware of any information on differential mortalities due to cold winter temperatures in small and large Manila clams, but suspects that small clams are likely more susceptible than large clams to winter kills. Another point worth considering is the limited habitat for Manila clams on the Central Coast. The reviewer agrees with the recommendations, and the initial arbitrary quota should be updated. The reviewer mentioned the failure of harvest log cards in the past, and wishes the authors luck in successfully implementing this recommendation. Overall the reviewer felt this was a good paper.

Subcommittee Discussion

In considering the recommendation of the paper to reduce the quota, it was recognised that the initial quota had been established arbitrarily. There was discussion on the appropriateness of using the average catch to develop a new quota reference point. There is literature suggesting that < 50 % of the historical average can be considered precautionary. However, it was noted that while this may work for long-term fisheries, it may not be appropriate for recent fisheries with high initial landings. There were further suggestions to use the Magnusson-Stefanson feed back rule for setting target reference points rather than mean catches, once adequate data are available.

There was Subcommittee discussion on index beaches, and the question was asked whether it was realistic to have index beaches. Index beaches would need to be linked to sub-area production. The revisions to the paper should include more discussion on index beaches. It was suggested that index beaches should be located in both fished and unfished (reference/protected) areas. There was discussion on the logistics of implementing this suggestion and the use of contaminated beaches as a reference was suggested. The location of index beaches should be carefully considered, as they should not be located only in areas of high recruitment, but also in average and marginal areas.

There was Subcommittee discussion on the issue of clams for food, social and ceremonial (FSC) purposes. It was noted that there was no discussion on FSC in

the paper, and the authors suggested there may be opportunities to provide clam species for FSC that are not the target of commercial interests, such as littleneck and butter clams.

There was considerable discussion on management considerations vs. recommendations. Allocation issues were raised with respect to food, social, and ceremonial issues. However the Subcommittee was informed by the local fisheries manager that there was a local consensus on removing littlenecks and butter clams from the management plan, and leaving Manila clams for the commercial fishery. This did not detract using Manila clams for FSC.

Subcommittee Recommendations

1. The Subcommittee recommended the paper be accepted with minor revisions;
2. The Subcommittee accepted the recommendation from the paper to reduce the quota below 73 t (a greater than 36% reduction from the previous arbitrary quota), but recommended refining the quota estimate by using additional information from the literature to consider other reference points;
3. The Subcommittee accepted the recommendation from the paper on an annual assessment of index beaches, and recommended exploring the use of reference beaches as additional index beaches;
4. The Subcommittee accepted the recommendation from the working paper to develop a harvest log card, and noted that actions are already being taken to implement harvest log cards with daily reporting;
5. The Subcommittee accepted the recommendation from the paper on catch and effort monitoring, but noted that there needs to be definition or development of reference points to identify when CPUE has been "radically reduced" in a particular location..

I99-18: Framework for goose barnacle (*Pollicipes polymerus* Sowerby, 1833) fishery in waters off the West Coast of Canada

R. Lauzier
Accepted subject to revisions

Summary

As a result of the Phase 0 review of the biology and fisheries of the goose barnacle (*Pollicipes polymerus* Sowerby, 1833) and the concerns expressed by the Invertebrate Subcommittee/Pacific Scientific Advice Review Committee (PSARC), the Resource Management Executive Committee (RMEC) recommended closing the fishery. The fishery was closed by Fisheries Management on May 30, 1999. Any re-opening or development of the goose barnacle fishery would depend on the results of an ecological impact assessment and meeting the criteria for a new and developing fishery. This paper summarises

the Phase 0 review and recommendations.

A framework for assessment and management of this fishery is then presented which allows for the fishery to proceed cautiously under scientific licence, and in a manner which collects key information for ongoing assessments and management actions. Components of the proposed framework incorporate the concerns expressed by the Invertebrate Subcommittee including non-selective harvest techniques; impacts on breeding success; discards; catch reporting and sustainability. Suggestions for the resolution of these concerns are presented. Data requirements for a precautionary fishery are outlined including removal estimates; abundance estimates and biological information. Assessment models and their data requirements are discussed. Alternative harvest practices are presented. Management options and their data requirements are presented.

Recommendations are made for the development of the goose barnacle fishery to follow the phased approach described in the Pacific Region Policy for New and Developing Fisheries, with suggestions on how this may be accomplished.

Reviewers' Comments

Reviewer #1

Reviewer #1 found the paper to be needlessly complex and data intensive, and recommended that it be substantially reduced and modified to address the key concerns and develop a clearer and more concise framework. The purpose of the paper was clearly stated, although concern was expressed that the data and methods were insufficient to support some of the recommendations contained in the paper. In addition, the reviewer suggested that the recommendations were not sufficiently clear so that they would be understood by a Fisheries Manager.

The reviewer suggested that reductions could be made to the pre-fishery survey requirements, and suggested conducting surveys of only some index sites. In addition, the reviewer felt that collection of biological information on age, growth, recruitment, and natural mortality were scientifically interesting, but that there were other priorities that would be more useful.

The reviewer agreed with the authors recommendation to include stakeholders in the planning and implementation of surveys and experiments, and offered the assistance of the NTC fisheries staff. The reviewer suggests that research could be conducted while proceeding with re-opening of the gooseneck barnacle fishery. The reviewer also suggested that for species like gooseneck barnacles, management models that derive from forestry might be better suited than traditional fisheries models.

Reviewer #2:

Reviewer #2 commended the author for preparing an interesting paper which addresses a complex issue. However, the reviewer found the objectives poorly presented, questioned the intensive survey requirements, and found the recommendations too vague to recommend their complete acceptance. The reviewer pointed out that some statements are not well supported in the text, and suggested that uncertainty in terms of stock status should be labelled as a concern; but that speculation and conclusions such as "stocks are over-utilised" can not, and should not, be made in the manuscript.

The reviewer questioned how all the data requirements and information was to be linked together in the context of re-opening the fishery. Also the reviewer questioned the effectiveness of observers on the grounds.

Reviewer #3:

Reviewer #3 recommended approval of this working paper and commended the author on the thoroughness of the paper.

The reviewer felt that the purpose of the paper, data, and methods were well presented, and that they supported the conclusions contained in the paper. The stated objective of providing a framework for the assessment of the goose barnacle stocks had been met, along with presenting management options.

The reviewer pointed out that although this is a good starting point, there may be further data needs in the future to deal with issues revolving around ecological impacts on the rocky inter-tidal community.

Subcommittee Discussion

The Subcommittee noted that this paper was prepared in conjunction with a paper on habitat issues in the fishery, which was to be presented in the habitat PSARC meeting the following week, December 7-8, 1999 (H99-04: Jamieson *et al.* 1999). The Subcommittee recommended that, in future, such linked papers should be presented jointly.

There was discussion on the nature of the outstanding unknowns with this species, specifically the size (and distribution) of the total population; the size (and distribution) of the proportion accessible to harvest, and the relationships (linkages) between accessible and inaccessible portions of the population. It was noted that for a sustainable fishery, the catch should reflect the recruitment rate to the accessible portion of the stock. The question was raised, therefore, as to whether there was a conservation concern with the whole population, or whether the concern was for the sustainability of a fishery on the accessible portion of the stock. Although no consensus was reached (because of uncertainties about the

intensity of harvest), it was felt the latter problem (re sustainability of the fishery) was the major concern.

Discussion of other unknowns included genetics and whether there was more than one stock of goose barnacles on the B.C. coast. Currently there is insufficient information to determine the population(s). Other points included what makes an area inaccessible to harvest, and the possibility for harvesting to "creep" into previously inaccessible areas as techniques develop.

The Subcommittee noted that alternative (to a quota system) management scenarios were possible, e.g. rotational fisheries. The priority research needs would change if Fisheries Management chose these alternative options. It is still important to have an estimate of the over-all stock size and its distribution in order to determine the risks associated with the management plan(s), and to evaluate management actions. This is important in order to implement biological reference points.

There were discussions on obtaining catch and biological data and whether observers are required if licencing were to be conducted under scientific licences. It was suggested that pre-harvest surveys should be done, followed by post-harvest assessments in order to obtain results of harvest impacts that are not influenced by having observers present during the fishing activity.

The Subcommittee expressed general agreement with recommendations of the paper on the need for a broad-brush survey/inventory (Rec.#1); the need for index and control sites (Rec.#4); consideration of rotational harvests and refugia (Rec.#7); the development of selective harvest techniques (Rec.#8); development of a code of responsible harvesting (Rec.#9); and establishment of experimental fishing/management areas (Rec.#11). The Subcommittee unanimously endorsed Recommendation #12 on the need to work with stakeholders in the development of these research plans. Other recommendations from the paper were considered important, but views differed as to their priority.

The Subcommittee noted, however, that these recommendations needed to be prioritised and a timeline prepared. The Subcommittee recommended the top three research priorities should be (1) the broad-brush abundance and distribution inventory; (2) identification of the proportion accessible to harvest; and (3) development of index study sites.

Discussions occurred regarding the optimal means to obtain the necessary data. A proposal was made to task a group representing DFO and stakeholders to examine the recommendations of the two papers (this and the habitat paper) and to present a proposal to senior management.

Subcommittee Recommendations

1. The Subcommittee accepted the working paper subject to minor revisions;
2. In future, papers that are linked between PSARC Subcommittees should be presented jointly;
3. The Subcommittee recommended supporting recommendation numbers 1, 4, 7, 8, 9, 11, 12 from the working paper, dealing with surveys, index sites, rotational harvests, harvest techniques, a code of harvesting, and the involvement of stakeholders;
4. The Subcommittee recommended that the initial research priorities should be to identify the large-scale distribution, establish index and study sites, and obtain estimates of the stock proportion(s) available (accessible) to harvest;
5. The Subcommittee recommended establishing a working group composed of DFO Science and Fisheries Management staff and stakeholders to examine the recommendations resulting from this paper and the habitat paper by Jamieson *et al.*(1999) to develop a strategy to implement the assessment and management framework for this species by May 2000.

I99-19 *Pandalus hypsinotus*, Humpback shrimp: A review of the biology and a recommended assessment framework for a directed fishery

J.A Boutillier and H. Nguyen
Accepted subject to revisions

Summary

The Minister of Fisheries and Oceans has directed that any expansion of a fishery for humpback shrimp, *Pandalus hypsinotus*, into non-traditional areas or with new or modified trawl or trap gear will be subject to the Pacific Region Guidelines on New and Developing fisheries. This paper was produced to address the issue of development of an assessment and management framework for this species given the biology and fishing history on this animal.

The important aspects of the biology that the assessment framework must address will include variable growth rates between areas, ability of the animals to produce primary females, and the potential multiparous nature of these animals. The important aspects of the fisheries that need to be considered when developing a management framework are: 1) the inability to develop guidelines for escapement targets for these animals without a history of fishing and recruitment success and 2) the difficulties that all other nations have had with developing a sustainable fishery for this species.

The paper concluded that there was potential within B.C. coastal waters for targeted humpback shrimp fisheries. There were a number of suggestions on how this fishery may go forward under a precautionary framework. The key aspects to the precautionary framework included: removal of specific areas from the trap and trawl fisheries for other shrimp species; recommended target and

limit reference points and adoption of experimental management approaches to address knowledge gaps, e.g. assessment methodologies, appropriate exploitation levels, reproductive potential etc.

Reviewers' Comments

Reviewer #1

Reviewer 1 felt that although the paper addresses the objectives as stated in the title, a lot of known literature on this and related species is not cited. In addition, the reviewer felt that many terms used in the paper are not properly defined and thus leave the reader confused. The reviewer agreed with the recommendations as presented by the author, and added that the data support the conclusions drawn. The life history section needs more information, as do the trophic relationships and Canadian management sections. Survey methodology is explained, but not clearly enough. The reviewer was left wondering whether the paper represents a Phase 0 or a Phase 1, or both.

Overall, Reviewer 1 felt that this is a well-organized and readable paper, but that several points in the text require clarification or expansion.

Reviewer #2

Reviewer 2 found the purpose of the paper to be clearly stated, and the data and methods adequate, considering the difficulty in assessing shrimp. He noted that there is never enough data to support the assessment needs for shrimp, but those presented are adequate.

Reviewer 2 felt the recommendations are useful to managers, but noted that the exploitation rate of humpbacks should be reduced substantially from that accepted for other species. He also noted that the bycatch of humpbacks in fisheries directed toward other shrimp species should be reduced, and that a trap fishery is a preferable method of maintaining this reduction.

The reviewer suggested that the life history section be expanded, that some edits be made to the population structure section, and that the authors review the experiences of the humpback fishery in Homer, Alaska.

Subcommittee Discussion

The Subcommittee noted that more information is required in many sections of the working paper. Many members thought the paper was going to represent a Phase 0 document, and felt that a lot of the background information that forms a Phase 0 was missing. In particular, information on landings and areas fished, information from shrimp trawl surveys, and length frequency modal analysis was not presented. The author responded that although the catch and area

information is available, it is comes under the confidentiality requirements of the harvest log program and cannot be released in a public document. It was suggested that this information be discussed with managers. However, trawl survey information could be added, and any available growth information can be reviewed for possible inclusion.

There was a concern expressed on the part of fishers that management actions (e.g. seasonal closures) may skew the fisheries data, and thereby produce an incorrect picture of the availability and biology of *P. hypsinotus*. There is also the potential for gear conflicts (e.g. between trap and trawl gears) should this species proceed to become a directed fishery. The Subcommittee recognised a need to define the criteria that might be used to identify areas of interest for a directed *P. hypsinotus* fishery.

The Subcommittee discussed the recommendations made in the paper, and noted that:

- the areas fished for humpbacks in the trap and trawl fisheries need to be identified before they can be removed;
- there is a general lack of information on humpbacks from the prawn trap fishery, which may require changes to the logbooks to capture;
- reference points need to be developed for this species;
- establishment of experimental management areas may be premature as it was felt that this fishery has not been adequately addressed through the phased approach.

Subcommittee Recommendations

1. The Subcommittee accepted the paper subject to revisions;
2. Identify the areas of interest for *P. hypsinotus*, perhaps using the percentage of catch comprising *P. hypsinotus* as one guide;
3. Discuss the management options presented in the paper with Fisheries Management staff, and identify reference points and their data requirements. This could be done through a paper which would focus on collecting the key information that is lacking and building interim reference points.

I99-20 A progress report on the controls of the growth and recruitment overfishing in the shrimp trap fishery in British Columbia

J. A. Boutillier and J. Bond

Accepted subject to revisions.

Summary

Management of growth and recruitment overfishing in the spot prawn (*Pandalus platyceros*) trap fishery in British Columbia is managed using size limits and a fixed escapement system. The fixed escapement is implemented using an index

of the number of spawner/trap caught in the commercial fishery. The development and application of this system is reviewed, including a description of the theoretical basis for this method of management, the problems with implementation, and the implementation procedure.

The size limits were introduced in 1985 and implemented in 1988. Industry has recognised the benefits of the size limits and has recently suggested increases.

The fixed escapement system was initially based on empirical survey data. To evaluate the efficacy of this management system a number of experimental management areas were developed. This paper will review the present state of progress in the development of a more model-based rationale for this system using data gathered from one of these experimental management areas, Howe Sound.

Howe Sound has been closely monitored as an experimental prawn management area since 1985. Data available for the area includes catch records from the commercial fishery, biological sampling and catch composition monitoring of the fishery, and detailed information from pre- and post-fishery research surveys carried out every year. This paper reviews the findings and suggests directions for further work.

Reviewers' Comments

Reviewer #1

The reviewer felt that the paper was worth while but would have benefited from more detail. Specifically, the reviewer thought that a simulation analysis, based on observed values of the biological parameters, spawner indices and stock-recruit data to examine the performance of the tactics under alternative scenarios, would have been useful. He felt that overall there was too little presentation of data illustrating the application of the spawner index, it's variability over areas and time and the details on recruitment over- fishing. The reviewer felt that an exact description of the criteria used to trigger a management decision was missing from the document. He felt an example was needed to show how the abundance indices during non-fishing periods compared to those during fishing periods, and to illustrate the agreement between fishery independent measures and commercial biological sampling information. The reviewer had specific suggestions concerning estimating the parameters of the Beverton-Holt equation and concluded with a number of editorial comments for the authors.

Subcommittee Discussion

The Subcommittee was pleased to see analyses presented of the unique situation provided by the Howe Sound prawn closure. The Subcommittee noted

that there are no formal recommendations presented in this working paper, but the Subcommittee supported the research directions outlined. Future work should include an analysis and presentation of the fisheries-independent data collected from areas open to commercial fishing in Howe Sound for comparisons with the closed area. The Subcommittee encouraged the establishment of fisheries-independent study sites in different areas of the B.C. coast to determine if the reference pcints developed for Howe Sound are applicable coastwide. The Subcommittee noted that the optimal value of the reference point may vary by area, and this needs to be investigated.

Subcommittee Recommendations

1. The Subcommittee accepted the paper subject to revisions;
2. Conduct a comparative analysis of fishery-independent data from the closed and open areas of Howe Sound.
3. Begin to develop fishery-independent data series for prawns in other areas of the B.C. coast.

I99-21 Assessment tools for data-limited fisheries

Z.Y. Zhang
Accepted subject to revisions.

Summary

One of the precautionary management approaches is to set up a pair of reference points, a target reference point (TRP) and a limit reference point (LRP). An TRP indicates the exploitation target and an LRP defines the limit, toward which management strives. TRPs and LRPs are formulated through technical analysis. This paper describes various empirical equations and fisheries assessment models, which can be used to derive reference points. The emphasis was put on the data requirement and procedures for fitting models and estimating parameters. Assumptions involved in the models are described. The bootstrapping and Monte Carlo simulation techniques are illustrated. In addition, various ways of estimating growth, stock abundance and mortality are introduced, as they are important parameters in the study of population dynamics.

Reviewers' Comments

Reviewer #1

Reviewer 1 felt that, while nothing major was missing from the summary, the review of assessment tools presented was dated to the point of being misleading. Some information given was factually incorrect, and model performance was, in some cases, over-stated. The reviewer felt that this was a poor use of the author's skills, since no new material was presented that cannot be found in the

literature.

Reviewer 1 expressed concern that these criticisms will lead to additional work on this document and suggested that the Subcommittee urge termination of the project. If the general approach is to be continued, the reviewer suggested that the next step should be a compilation and review of current invertebrate assessments around the world.

Reviewer # 2

Reviewer 2 felt that the paper was well written and fairly comprehensive, was successful in clearly stating its purpose and explaining in sufficient detail the methods and data requirements for each tool. The reviewer had no major concerns with the working paper and felt that the discussion and recommendations were very useful.

Reviewer 2 had a number of suggestions for additional areas to be included in the working paper, including a description of the Bayesian approach for parameter estimation. The reviewer suggested that more information on methods to estimate natural mortality be presented, given its importance in reference point determination. Reviewer 2 also suggested that methods for constructing confidence intervals using bootstrap be included.

Subcommittee Discussion

The Subcommittee endorsed the move towards calculating and recommending reference points in invertebrate stock assessments and recognised that this Working Paper was a useful exercise in bringing forth concepts and reviewing methodologies. While it was felt that radical revisions were not warranted because many excellent textbooks and documents on the subject currently exist, the paper could be made more useful if focus were given to the practical application of reference points and examples provided from current invertebrate fisheries. Some concern was expressed that unreasonable expectations may be built and that ambitious pursuit of these objectives are not achievable. There was an acknowledgement that most of the methods require data that are unavailable at present for most developing invertebrate fisheries.

Subcommittee Recommendations

1. The Subcommittee accepted the paper subject to revisions;
2. The Subcommittee endorsed the recommendations of the paper regarding moving towards developing reference points in invertebrate stock assessments, establishing pre-agreed actions that would be implemented if the reference points were approached, and regular review and updating of the reference points as more data are collected.

I99-22 Distribution, abundance, biology and fisheries potential of the exotic varnish clam (*Nuttallia obscurata*) in British Columbia

G.E. Gillespie, M. Parker, and W. Merilees
Accepted subject to revisions

Summary

Varnish clams, *Nuttallia obscurata*, have recently become established in Georgia Strait, and have been found in Barkley Sound on the west coast of Vancouver Island and estuaries in Oregon. They are dispersing southward into Puget Sound, and could spread northward into the Central Coast, similar to Manila clams.

This paper discusses distribution and dispersal of varnish clams and collects available information on biology, ecology and population dynamics (from the literature and other sources). This information is summarized, and gaps in required information are identified. The fishery potential, management approaches and assessment information requirements to develop and evaluate the effectiveness of management tactics are discussed.

The paper suggests that varnish clams have potential as commercial and recreational resources, and should be managed accordingly.

Reviewers' Comments

Reviewer #1

Reviewer 1 commended the authors on the amount of work on this manuscript. The Phase 0 document summarises available information on varnish clams. The reviewer is pleased to see that an excellent record is being kept of the introduction and subsequent dispersal of this exotic species. The reviewer's main comment was that this document should be summarised and published in a recognised journal so that the information is available to the scientific community. The major criticism of this document is that it reads at times like a thesis in which a student is trying to impress a professor with the amount of literature covered on the subject. Parts of the manuscript could be omitted or greatly shortened without detracting from the document, e.g. much of the information on other exotic introductions could be omitted. The fishery potential will depend on whether the stocks are sufficient, the costs of harvesting and processing, and whether market prices are sufficient to make the fishery profitable. There appear to be strong markets and the clam supply is limited. It is doubtful that landings of varnish clams would be large enough to affect Manila clam markets. If there is a commercial potential for varnish clams, then industry should be allowed to develop it. The reviewer pointed out this situation is analogous to the soft-shell clam, in that a commercial fishery will only develop if it is economically viable. The reviewer agreed with the recommendations and had no other suggestions

for recommendations.

Reviewer #2

Reviewer 2 found that this working paper was well researched, the purpose was clearly stated, and the paper identified data and information gaps. The reviewer was surprised by the amount of data collected from the Strait of Georgia over the short time span from 1995 to 1999. The reviewer limited his comments to the management aspects of this fishery with a view to a fishery potential. The reviewer agreed that there was a lack of information on fishery impacts on this species elsewhere, and there is a need to establish a scientifically based collection of information. Some groups in the intertidal clam fishery may be able to assist in collecting the required information. The reviewer suggested that the issue of competition with other species could be explored by collaboration with the aquaculture industry on clam tenures. The reviewer suggested that there may be available information from the processors on the size preferred by consumers, and this should be included in the paper. The reviewer agreed with the recommendations presented in the paper. This species has potential commercial and recreational value rather than only being a nuisance species, until proven otherwise. The commercial fishery for this species should be added to the existing intertidal Manila clam fishery, which is actively managed, and also because of the shift towards ecosystem-based management. The issue of competition with Manila clam stocks is a very important issue to the intertidal clam industry, and the reviewer suggested this should be identified as a research priority in the recommendations section. The reviewer found the working paper to be a useful document from a management perspective, as it outlines the information shortfalls, identifies areas of concern in management issues, outlines options, and provides recommendations that are flexible and within the capability of the existing commercial intertidal clam fishery and aquaculture industry.

Reviewer #3

The reviewer found the paper to be well researched, very well written and very informative. The purpose of the paper was well stated and the data cited appeared to support the conclusions presented. While the data cited were fairly clear, the sampling methods were not spelled out in great detail, but this is probably reasonable, since most of the paper was essentially a literature review. The paper covered essentially all aspects of the biology and ecology of Nuttallia, and its future possible value to a commercial or sport fishery. This reviewer felt that the recommendations are clear, reasonably substantiated, and should be useful to fisheries managers.

The reviewer suggested including a map showing locations cited in the paper. The reviewer commented that if harvest size is set too high, you may run into the problem of "undesirable creaminess" in the larger clams at some times of the year. He suggested that optimum harvest size, from a taste perspective, is

probably in the range of 25-40 mm TL. He indicated that he had collected varnish clams up to 68 mm TL, larger than the maximum size reported in the paper. This reviewer included other editorial comments.

Subcommittee Discussion

It was noted that varnish clams grow considerably larger on the B.C. coast than in their native habitat off Korea. In B.C. they have also recently been found in Kyuquot Sound on northwest Vancouver Island.

This paper does a good job in considering the ecosystem context of this species, as reflected in the discussion in the paper on competition and habitat preferences, as well as potential varnish clam fishery interactions with the Manila clam fishery.

There was considerable discussion on where this paper fit within the phased assessment process for new fisheries. The paper is a Phase 0 literature (and data) review. However, it makes recommendations for how to incorporate harvest of this species into present clam harvesting activities, which could be considered as Phase 2 of the process (i.e. development of a commercial fishery). The Subcommittee felt that there were still a number of outstanding unknowns, e.g. relating to management reference points and harvesting impacts on other species (such as Manila clams), that a Phase 1 paper to examine these issues is warranted.

Subcommittee Recommendations

1. The Subcommittee accepted the paper subject to revisions;
2. The Subcommittee endorsed the recommendations in the paper regarding:
   - considering varnish clams as a recreational and commercial opportunity;
   - that a varnish clam fishery should be incorporated into the existing clam licence;
   - that no additional varnish clam harvests should continue once Manila clam conservation thresholds have been reached;
   - that clam tenures could be used to study varnish clam – Manila clam interactions;
   - that a complete investigation of varnish clams will require studies and comparisons of beaches currently with and without varnish clams.
3. The Subcommittee recommended that research gaps be prioritised based on the management approaches proposed in this paper. This could lead to a combined Phase 1 and Phase 2 paper, which would develop reference points (e.g. appropriate size limits) and also consider ecological interactions with other clam species.

I99-23 Quota option for the red sea urchin fishery in B.C. for fishing season in 2000/01

A. Campbell, W. Hajas, D. Bureau
Accepted subject to revisions

Summary

Annual landings of red sea urchin (*Strongylocentrotus franciscanus*) increased rapidly in the early 1980s for the south coast of British Columbia (B.C.) and in the late 1980s for the north coast, but subsequently were reduced and stabilised by arbitrary quotas. Coastwide landings were 5091 t valued at $ 7.4 M (Cdn.), with 110 licenses issued during the 1998/99 fishing season. Bed areas were obtained by digitising locations on charts indicated in harvest logbooks. Analyses of recent surveys and review of published survey reports provided estimates of mean density and weights allowing preliminary estimates of red sea urchin biomass in B.C. Based on recent published reports and preliminary estimates in B.C. natural mortality rates of red sea urchins was assumed for fishery management purposes to be between 0.05 and 0.10. Since Industry and managers requested an evaluation of the present legal size limit (≥ 100 mm test diameter, TD) and implications of reducing the size limit, estimated biomass and quota options were calculated and discussed for a variety of size limits of ≥ 90, ≥ 100, 100-140, 90-120, and 90-130 mm TD for red sea urchins in B.C. Further surveys for red sea urchin density are required, especially in some areas of the south coast of B.C. where surveys are > 10 years old, and in areas in the North Coast that have been heavily fished. More accurate estimates of bed areas, natural mortality and recruitment rates for red sea urchins in most areas of B.C. are required to manage this fishery on a bed by bed basis.

Reviewers' Comments

Reviewer #1

This reviewer recommended acceptance, and considered the approach correct and appropriate for assessing red urchins. However, the reviewer also noted large uncertainties in a number of key parameters. Questions arise from not completely understanding the biology of the animal and with the lack of explicit consideration of roe (since this is a roe fishery). There is also a question of senescence of the urchins (e.g. that egg quality and viability from older animals is not as good), whether it occurs, and if it has been examined.

The reviewer questioned the ageing of the animals and how the natural mortality rate was determined. The reviewer noted that an M of 0.1 suggests a mean generation length of about 100 years. Further questions pertained to the variability between beds and if data collected on surveys from one bed were then utilised to determine biomass for adjacent beds within the area. Is biomass is

being determined on a bed by bed basis or over the whole sub-area?

The reviewer also questioned the overall implications of restricting size range to a minimum or maximum? Could it lead to other problems, such as enforcement issues? The reviewer suggested considering rotating harvest.

Reviewer #2

This reviewer felt that the purpose of the paper was clearly outlined, that the data supported the conclusions, that the recommendations were provided in a useful form for fisheries managers, and that the uncertainties were well identified. In addition, the reviewer noted that estimating bed areas only to 9.1 m depth appeared too shallow. The estimate of M=0.1 seemed reasonable considering work conducted elsewhere. The reviewer concluded that the paper was well done, and agreed that the most important unknowns are reliable density and bed-area estimates.

Subcommittee Discussion

The Subcommittee focussed discussion on the two central aspects of this paper: (1) development of the TAC assuming continuation of the present 100 mm minimum size limit; and (2) quota options for a range of alternative size limits.

There was considerable discussion on the method by which red urchin biomass was calculated from the survey data. The present method is to conduct randomly-located transects throughout the entire statistical sub-area, and then to multiply the mean biomass/m^2 derived from these surveys by the estimated area of the fishing beds within this sub-area. It was noted that data on fishing bed areas are available only up to 1996, and that considerable changes may have occurred since then. In addition, bed areas have been calculated to a maximum depth of only 9.1 m, whereas there is anecdotal evidence that fishing now occurs deeper in some areas. The principal concern, however, was that the mean density estimated over the whole sub-area should be multiplied by the total area (less than 9.1 m depth) of that sub-area, rather than the area of the fishing beds. If the fishing bed area was to be used, then the transects should be selected randomly within fishing beds. It was noted that the present method of calculating total biomass is more conservative than using the total area (shallower than 9.1 m). A directed study that would compare these alternative survey methods in a "well-known" sub-area was recommended, and would also help to determine the optimal number of transects to sample within a sub-area.

The Subcommittee also expressed concerns that some sub-areas have not been surveyed for estimates of mean densities in over 10 years. It was recommended that such old data, and the TAC's resulting from these data, be treated cautiously. The Subcommittee also recommended that statistical resampling procedures be used to estimate the uncertainties involved in extrapolating density information

from adjacent sub-areas or areas to those sub-areas and areas from which density estimates are not available (or too old).

There was considerable Subcommittee discussion on the coefficient of natural mortality (M) for red sea urchins. This is a subject that needs further research, and is under investigation. A wide range of M values (and resulting TAC's) are presented in the paper. A value of M=0.1 was agreed as a compromise to the range presented, however, fisheries managers expressed satisfaction with the flexibility the range provided.

The Subcommittee complimented the authors on the appendices, which represent the initial development of yield per recruit models and population simulations to investigate the impacts of harvesting and the probabilities of stock collapse. These models were also used to develop scenarios for alternative size limits. The authors were encouraged to develop these appendices towards publications. The Subcommittee recognised that selection of specific size limits was a fisheries management decision, and that the implications of the different scenarios were described in the paper (TAC's with the range of M and size limit options from the paper are shown in Table 1). The Subcommittee further noted that lowering the minimum size limit and applying a maximum size limit could result in a substantial reduction in the TAC, in order to adhere to a 2% exploitation rate. Implementing a maximum size limit could also provide protection to stocks for which biomass estimates are highly uncertain, by reserving large animals for reproduction. However, higher mortalities of red urchins could result if a maximum size limit were established along with a minimum limit, because of increased handling of animals. The Subcommittee endorsed the recommendation in the paper regarding experimental management areas to examine the effects of changes in size limits. It further suggested that rotational fisheries might be considered as a management option for this fishery, although the Subcommittee recognised that analyses of this option was not an objective of this paper.

Subcommittee Recommendations

The Subcommittee recommended:

1. accepting the paper subject to revisions;
2. that the calculation of bed areas using data collected since 1996 be given a high priority;
3. that in the absence of recent survey information to calculate mean densities in sub-areas, fisheries managers should be more cautious when calculating quotas for these sub-areas;
4. that a resampling analysis be conducted to determine the uncertainties associated with extrapolating mean densities to unsurveyed areas;
5. there be a field comparison test to resolve the random transect - subarea versus random transect - bed area calculations to estimate biomass. This

would also assist in determining optimal numbers of transects to be used in sub-areas;

6. that possible changes to the size limits are the decisions of fisheries management, but that they should be taken in consultation with industry. This paper outlines the scientific implications of possible different size limits.

FISHERY UPDATES

Red Sea Urchin

The 1998/99 fishery update was written in a new format in preparation for the 2000/2001 Integrated Fisheries Management Plan. The 1998/99 TAC was 5,601 t divided into 110 equal individual quotas of 247 t. This was a reduction of approximately 12% from the previous year as a result of new biological, survey and fishery-dependent data. For the 1998/99 season, Fisheries and Oceans Canada approved the implementation of a voting system to try and improve the fishing pattern and control the harvest rate. Unfortunately, all fishers did not adhere to the voting system, and there remains the need for a harvesting protocol that will satisfy both Fisheries and Oceans Canada and Industry requirements. The value of the fishery has decreased, likely as a result of economic and market conditions in Asia. Preliminary fish slip data show the fishery to be valued at $7.4 million for 1998/99. Advances on management issues have been made by resolving some historical issues, though basic biological, bed area and urchin density information is still poorly documented and requires continued focus in order to properly assess this fishery.

STOCK STATUS REPORTS

Five stock status reports were reviewed by the Subcommittee:

- red sea urchins;
- crabs in areas other than Area A;
- flying squid;
- varnish clams; and
- humpback shrimp.

Recommendations were provided to the authors for revisions. Once revised and approved by the Subcommittee chair, the stock status reports will be forwarded to the PSARC Secretariat for publication in the usual manner.

Table 1. Total quota (tonnes) options for the red sea urchin fishery by north and south B.C., estimated from various natural mortality values applied to current biomass (B_c) calculated from mean and approximate 90% confidence intervals (CI), biomass values for five size limits of commercial red sea urchins, and bed areas fished up to 1996. (From PSARC I99-23).

		Quota 0.2 M Bc							
Size Limit	Region	M = 0.052		M = 0.075		M = 0.10		M = 0.15	
(mm TD)		Mean	Lower 90 % CI	Mean	Lower 90 % CI	Mean	Lower 90 % CI	Mean	Lower 90 % CI
≥100	North Coast	2753.6	1948.6	3971.6	2810.5	5295.4	3747.3	7943.1	5620.9
	South Coast	543.0	307.7	783.2	443.8	1044.3	591.7	1566.5	887.5
	B.C.	3296.6	2256.3	4754.8	3254.3	6339.7	4339.0	9509.6	6508.4
100-140	North Coast	2421.9	1685.1	3493.2	2430.5	4657.6	3240.6	6986.4	4860.9
	South Coast	445.9	249.6	643.1	360.0	857.4	480.0	1286.1	720.0
	B.C.	2867.8	1934.7	4136.3	2790.5	5515.0	3720.6	8272.5	5580.9
≥90	North Coast	3222.5	2294.8	4647.9	3309.8	6197.2	4413.1	9295.7	6619.7
	South Coast	613.3	352.8	884.5	508.9	1179.4	678.5	1769.1	1017.7
	B.C.	3835.8	2647.6	5532.4	3818.7	7376.6	5091.6	11064.8	7637.4
90-120	North Coast	1934.3	1387.1	2789.9	2000.6	3719.8	2667.5	5579.8	4001.2
	South Coast	303.9	161.0	438.3	261.1	584.4	348.1	876.7	522.1
	B.C.	2238.2	1568.1	3228.2	2261.7	4304.2	3015.6	6456.5	4523.3
90-130	North Coast	2481.5	1780.4	3579.1	2567.9	4772.2	3423.9	7158.3	5135.9
	South Coast	409.3	242.8	590.4	350.1	787.2	466.9	1180.5	700.3
	B.C.	2890.8	2023.2	4169.5	2918.0	5559.4	3890.8	8338.8	5836.2

APPENDIX 1. PSARC INVERTEBRATE SUBCOMMITTEE MEETING AGENDA, NOVEMBER 30 – DECEMBER 3, 1999

	30 November Tuesday Start 0900	1 December Wednesday Start 0830	2 December Thursday Start 0830	3 December Friday Start 0900
AM 1	Introduction and Procedures I99-23 (Red Sea Urchin) Review Red Urchin SSR for updates/ revision	I99-17 (Area 7 Manila clam fishery)	I99-20 (Howe Sound prawns)	Year 2000 assessment priorities, in particular for next meeting Review of Thursday's Rapporteur's Report Closure
Break				
AM 2	Red Urchin Fishery update	I99-22 (Varnish clam Phase 0) Varnish clam SSR	I99-20 (cont.)	
Lunch				
PM 1	I99-21 (Assessment Tools)	I99-19 (Humpback shrimp Phase 0) + Humpback SSR	I99-18 (Gooseneck barnacle)	
Break				
PM 2	Crab Stock Status Report review Flying squid Stock Status Report review Emerging Issues	Abalone issue/document Emerging Issues Review of Tuesday's Rapporteur's Report	Gooseneck barnacle (cont.) Emerging Issues + Review of Wednesday's Rapporteur's Report	

APPENDIX 2: PSARC INVERTEBRATE WORKING PAPERS FOR FALL 1999.

No.	Title	Authors	Reviewers
I99-17	Review of the area 7 manila clam fishery	G. Gillespie T. Norgard and F. Scurrah	N. Bourne J. Rogers
I99-18	Framework for goose barnacle (*Pollicipes polymerus* Sowerby, 1833) fishery in waters off the West Coast of Canada	R. Lauzier	D. Clark G. Jamieson D. Hall
I99-19	*Pandalus hypsinotus*, humpback shrimp: A review of the biology and a recommended assessment framework for a directed fishery	J.A. Boutillier H. Nguyen	P. Anderson G. Workman
I99-20	A progress report on the controls of the growth and recruitment overfishing in the shrimp trap fishery in British Columbia	J.A. Boutillier J.A. Bond	R. Kronlund
I99-21	Assessment tools for data-limited fisheries	Z.Y. Zhang	R. Stanley J. Zheng
I99-22	Distribution, abundance, biology and fisheries potential of the exotic varnish clam (*Nuttallia obscurata*) in British Columbia	G.E. Gillespie M. Parker W. Merilees	N. Bourne R. Webb P. Dinnell
I99-23	Quota options for the red sea urchin fishery in B.C. for fishing season in 2000/01	A. Campbell W. Hajas D. Bureau	D. Welch A. Bradbury

APPENDIX 3: PARTICIPANTS AT INVERTEBRATE SUBCOMMITTEE MEETING, FALL 1999.

Subcommittee Chair: Ian Perry
PSARC Chair: Max Stocker

DFO Participants	Tues	Wed	Thurs
* Subcommittee Members			
G. Parker	✔	✔	✔
B. Adkins*	✔	✔	✔
J. Rogers*	✔	✔	✔
M. Kattilakoski		✔	✔
C. Hand*	✔	✔	✔
M. Stocker	✔	✔	✔
N. Olsen		✔	✔
R. Mylchreest*			
K. West*	✔	✔	✔
A. Phillips	✔	✔	✔
G. Workman	✔	✔	✔
W. Hajas	✔	✔	✔
G. Gillespie*	✔	✔	✔
D. Clark	✔	✔	✔
Z. Zhang	✔	✔	✔
J. Boutillier*	✔	✔	✔
R. Lauzier*	✔	✔	✔
E. Wylie	✔		✔
L. Convey		✔	
J. Moore*			
N. Bourne		✔	
F. Scurrah	✔	✔	✔
B. Koke*			
J. Morrison (representing R. Harbo*)	✔	✔	✔
H. Nguyen		✔	✔
A. Campbell*	✔	✔	✔
R. Webb		✔	
I. Winther		✔	✔
G. Jamieson*	✔	✔	✔
B. Lucas	✔	✔	
R. Stanley	✔		
I. Perry*	✔	✔	✔
D. Welch	✔		

External Participants:

H. Holmes (Parks Canada)	✔	✔	✔
N. Sloan (Parks Canada)	✔	✔	✔
D. Hall (NTC Tribal Council)			✔
J. Osborne (NTC Tribal Council)			✔
L. Clayton (Pacific Coast Shrimpers Coop)		✔	
S. Campagna (Sea Cucumber Assoc.)	✔	✔	✔
D. Bureau (Pacific Urchin Harvesters Assoc.)	✔		
R. Jones (Haida Fisheries Program)	✔	✔	✔
T. Norgard (Heilsuk Fisheries Program)	✔	✔	✔

Observers:

E. Kim	✔		
B. Grant			✔
T. Hamilton			✔
J. Muirhead			✔
W. Cathcart			✔
Leonard Pavio			✔
Lucy Pavio			✔
R. Taylor		✔	
B. Stefiuk		✔	✔
K. Erikson		✔	✔